

Sustainable Vegetable Cultivation in the Nilgiris, Western Ghats through Valorization of Spent Mushroom Substrate

The Nilgiris region, renowned for its cool climate and fertile soils, provides an optimal environment for cultivating temperate vegetables. Recent research highlights the potential of Spent Mushroom Substrate (SMS)—a by-product of mushroom cultivation—as a sustainable supplement to traditional organic manures like farmyard and poultry manure. Field trials conducted by the ICAR-Indian Institute of Soil and Water Conservation (ICAR-IISWC) at its Research Centre in Udthagamandalam, specifically in Basavakkal village, have demonstrated that re-composting SMS with rock phosphate can significantly enhance vegetable yields. Notably, crops such as carrots, beetroots, and broccoli exhibited yield increases ranging from 6% to 23% compared to conventional farming practices.

Beyond yield improvements, the application of SMS has environmental benefits. Studies indicate that using SMS can reduce soil CO₂ emissions by approximately 26.5% compared to the use of traditional farmyard manure. This reduction contributes to a lower carbon footprint in agricultural practices. The integration of SMS into farming practices aligns with the principles of a circular economy, promoting the recycling and reuse of agricultural by-products. By repurposing SMS as a biofertilizer, farmers can enhance soil health, improve crop productivity, and adopt more sustainable and environmentally friendly agricultural methods. The utilization of Spent Mushroom Substrate offers a promising, eco-conscious alternative to traditional manures, fostering both agricultural productivity and environmental sustainability in the Nilgiris region.

VEGETABLE cultivation is a cornerstone of the Nilgiris district's economy, contributing significantly to its overall development. The region's cool climate and deep lateritic red sandy soils create an optimal environment for growing a variety of temperate vegetables, including carrots, potatoes, beetroots, cabbages, sprouting broccoli, and beans. These high-quality vegetables are in demand both domestically and internationally.

However, vegetable farming in the Nilgiris faces challenges due to climate change, with unpredictable weather patterns affecting crop yields. Additionally, the procurement of organic manures like farmyard manure (FYM) and poultry manure (PM) is hindered by inaccessibility and limited supply. Many farmers rely on transport from lower altitudes, increasing costs and causing delays. The scarcity of livestock in higher altitudes further limits the availability of locally produced FYM, and reliance on PM sourced from distant farms compounds logistical issues, impacting the cost-effectiveness of vegetable cultivation.

In recent years, the cultivation of white button mushrooms (*Agaricus bisporus*) has gained momentum in the Nilgiris, leading to the production of approximately 30,000 tonnes of spent mushroom substrate (SMS) annually. While often considered waste, SMS has emerged as a potential supplement to traditional organic manures. SMS offers a balanced mix of nutrients that are both immediately available and slowly released, supporting consistent plant growth. Its application can improve soil structure, water retention, and microbial activity, promoting better root development and nutrient uptake. Utilizing SMS as a supplement to FYM and PM presents a cost-effective way to recycle waste into valuable agricultural input, contributing to a circular farming system.

However, it is important to note that some farmers have been using raw SMS without proper composting or reinforcement, which may not yield significant benefits. Proper processing of SMS is essential to maximize its agronomic advantages and ensure its effectiveness as a soil amendment.

Table 1 Yield of different vegetable crops recorded in participatory field trials at Basavakkal village, The Nilgiris, Tamil Nadu

Crop	Farmers' practice	Tested practice	Yield (t ha ⁻¹)		% increase over the farmers' practice
			FP	TP	
Carrot	No. 4+ PM	No. 4+ SMC	54.60	59.72	9.38
Beet root	No. 4+ SMS	No. 4+ SMC	41.17	47.38	15.08
Cabbage	No. 4+ PM	No. 4+ SMC	62.99	66.87	6.17
Garlic	No. 4+ PM	No. 4+ SMC	18.32	19.08	4.14
Broccoli	No.4 + FYM	No. 4+ SMC	32.11	39.67	23.52

*No.4 is the fertilizer mixture commonly in use in the Nilgiris region having the NPK ratio of 6:12:6

*PM-Poultry Manure; SMS-Fresh Spent Mushroom Substrate; SMC-Spent Mushroom Compost; FYM-Farm Yard Manure; FYM, SMS & PM were applied @ 25 t ha⁻¹; SMC applied @ 20 t ha⁻¹ at the time of field preparation

*Yield data was collected from the 9×9 m² plot area in both the practices and projected as yield in t ha⁻¹

Recognizing the potential of Spent Mushroom Substrate (SMS) as a sustainable soil amendment, the ICAR-Indian Institute of Soil and Water Conservation (ICAR-IISWC), Research Centre, Udthagamandalam, initiated participatory field trials in collaboration with local farmers in Basavakkal village (Latitude: 11.3972° N; Longitude: 76.6500° E) within the Ooty Division of The Nilgiris district, Tamil Nadu. Building upon prior experimental findings, the SMS underwent an additional 90-day composting process, during which it was enriched with 2% rock phosphate by weight. This process transformed the substrate into Spent Mushroom Compost (SMC), enhancing its nutrient profile and suitability for agricultural use.

To ensure effective implementation, awareness programs were conducted to educate farmers on the benefits and application methods of SMC. Subsequently, the enriched compost was distributed to participating farmers. The field trials focused on evaluating the impact of SMC on the yields of various vegetable crops, including carrot, beetroot, garlic, cabbage, and broccoli. For comparative analysis, farmers' conventional practices served as the control, while the application of SMC represented the alternative practice. Yield data were meticulously collected from both sets of practices, and the results are summarized in Table 1.

Field trials conducted by the ICAR-Indian Institute of Soil and Water Conservation (ICAR-IISWC) Research Centre in Udthagamandalam have demonstrated the efficacy of Spent Mushroom Compost (SMC) in enhancing vegetable crop yields in the Nilgiris region. In these trials, SMC was compared to traditional organic manures such as poultry manure (PM) across various crops.

Yield improvements with SMC application

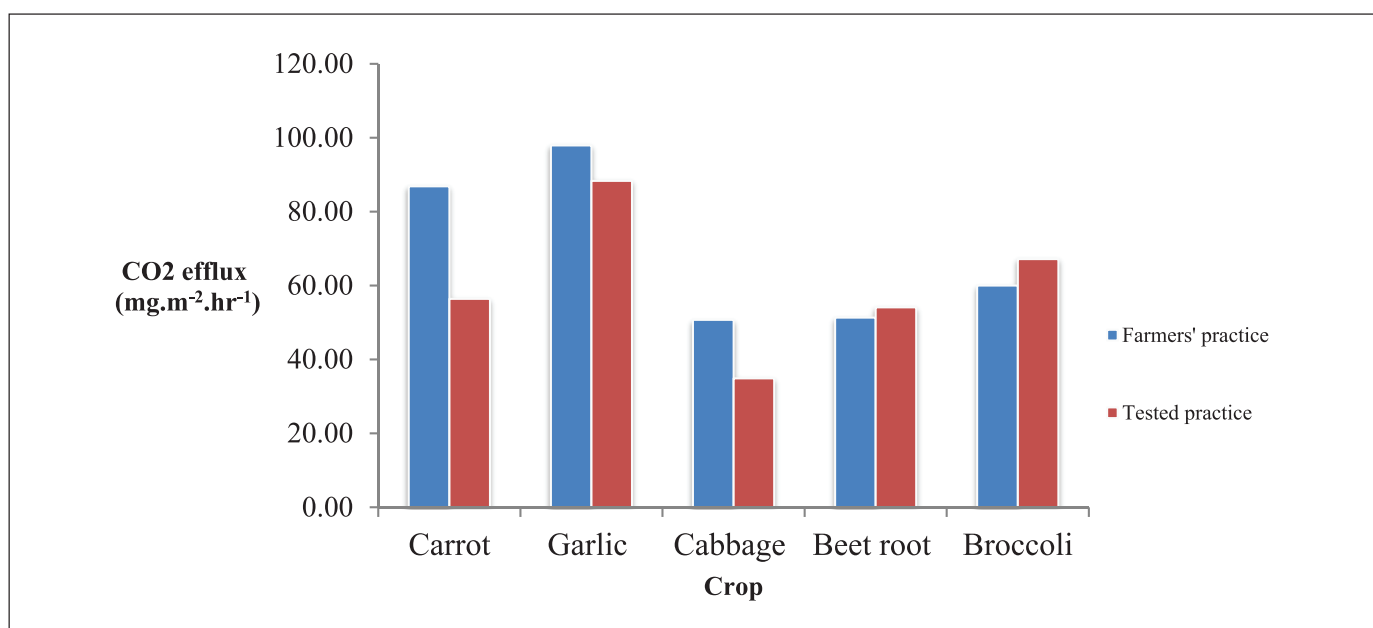
- **Carrot:** Yield increased from 54.60 t/ha under traditional practices to 59.72 t/ha with SMC, marking a 9.38% improvement.
- **Beetroot:** Yield rose from 41.17 t/ha to 47.38 t/ha, a 15.08% enhancement.
- **Broccoli:** Yield improved from 32.11 t/ha to 39.67 t/ha, reflecting a 23.52% increase.
- **Cabbage:** Yield saw a modest rise from 62.99 t/ha to 66.87 t/ha, a 6.17% gain.
- **Garlic:** Yield experienced a slight uptick from 18.32 t/ha to 19.08 t/ha, a 4.14% increase.

These results indicate that integrating SMC into fertilization practices can significantly boost yields, particularly in crops like broccoli, beetroot, and carrot, while also offering benefits for cabbage and garlic.





Participatory field trials conducted under the project “Re-composting of spent mushroom biomass for soil quality improvement and crop productivity enhancement” at Basavakkal village, The Nilgiris, Tamil Nadu during the year 2024-25



In situ soil CO₂ efflux at the harvesting stage of different vegetable crops recorded in participatory field trials at Basvakkal village, The Nilgiris, Tamil Nadu

Environmental Benefits

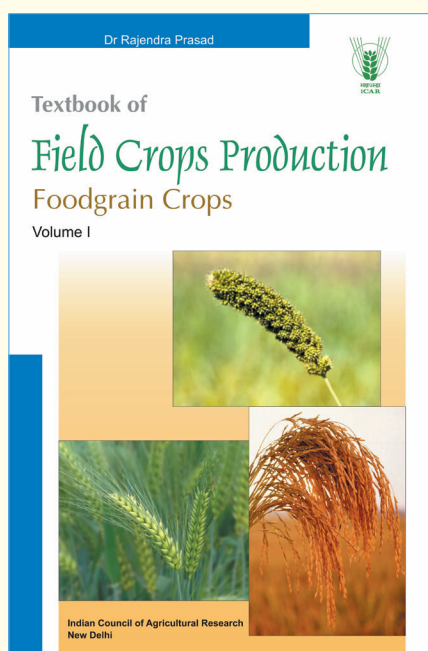
Beyond yield enhancements, the use of SMC has been associated with environmental advantages. Traditional organic manures, especially those transported from lower altitudes, contribute to higher soil CO₂ emissions, thereby increasing the agricultural carbon footprint. In contrast, SMC, being locally sourced and properly composted, can help mitigate these emissions. Field measurements using advanced equipment like the EGM-5 analyzer have shown that SMC application can lead to a reduction in soil CO₂ flux, contributing to more sustainable farming practices. The adoption of Spent Mushroom Compost in the Nilgiris region not only enhances vegetable crop yields but also promotes environmental sustainability by reducing greenhouse gas emissions.

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TECHNICAL SPECIFICATIONS

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